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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN OR RELATING TO SEA ANCHORS

(71) We, HONEYWELL INC., a Corporation organised and existing under the laws of the State of Delaware, United States of America, of 2701, Fourth Avenue South, Minneapolis, Minnesota 55408, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to sea anchors, that is to say anchors which are used to restrain a water borne body, such as a buoy or vessel from drifting away from a predetermined area or position. More particularly, the invention is concerned with sea anchors for use in multi-point anchoring systems, that is, systems in which two or more sea anchors are used to obtain more precise positioning of a water borne body than can be achieved using only one anchor. Multi-point anchoring systems are frequently used to anchor sonar buoys employed in oceanographic surveying, oil field exploration or underwater surveillance, where it is important to maintain a precise position of the buoy.

In multi-point anchoring systems used in the past, the sea anchors have been lowered one at a time vertically to the bottom of a body of water on one end of an anchor line which is supported at the surface of the water by a reference buoy. Once two or more sea anchors have been deployed some distance from one another (in a triangle or circle if more than two anchors are used), the reference buoys are collected by a service vessel and the anchor lines are coupled to the body that is to be anchored in position. The above procedure is very time consuming and thus expensive.

A sea anchor according to the invention comprises a torpedo-shaped body provided with wings and a flared tail for producing lift an drag, respectively, in a ratio that determines a glide path angle, at an acute angle relative to horizontal, which the anchor follows on sinking under its own weight in a body of water, the anchor body being further provided with fins for stabilizing the anchor in its glide path. The invention further provides a sea anchor assembly comprising at least two of the sea anchors each as defined in the last preceding paragraph and all mounted on a support in such predetermined attitudes relative to one another that when they are deployed, simultaneously, with an initial velocity from the support in a body of water they glide along divergent paths to widely separated stations at the bottom of the body of water, each anchor trailing behind it a respective anchor line that leads back to the support. In most cases it is preferred to use three or more anchors. Two anchors may, however, be used when, for example, it is desired only partly to limit movement of a buoy or vessel within a particular area or corridor.

Typically, a glide path angle of approximately 45° to horizontal for each anchor would be desired. It is preferred, therefore that the ratio of lift to drag is substantially 1:1.

The sum of the vertical components of lift and drag is calculated for each anchor as nearly as possible to counter-balance the weight of the anchor so that, when gliding, the anchor will experience little or no vertical acceleration. However, the vertical velocity component with which the anchor is launched remains and the anchor therefore proceeds on a downward course once launched from the support.

Preferably, the wings of each anchor are such that the centre of lift is co-incident with the centre of gravity of the body, though alternatively the centre of lift can be aligned with the centre of gravity along an axis which is vertical when the anchor is in its predetermined glide path attitude. The tail of each anchor preferably has a conical configuration flared in a direction away from the main body of the anchor.

The initial velocity with which each anchor is released from the support along its glide path is preferably produced by a spring,

though alternatively an explosives charge can be used for this purpose.

The support in a preferred anchor assembly according to the invention comprises a floatation body having at least two elongated guides extending from its underside, the guides respectively carrying the anchors and being arranged to direct the anchors along their respective glide paths. Each anchor is urged to slide off its respective guide by a spring and is normally restrained from doing so by a latch mechanism. Alternatively, the support can comprise a non-buoyant member supported on a line over the side of a vessel. Once the deployment of the anchors is completed, the anchor lines may be attached to a floating body or, for example, to a lighter-than-air balloon which may carry an aerial.

When the support comprises a floatation body, the latter preferably carries the anchor lines and means for controlling the length of line between each anchor and the support once the anchors have been released.

The invention will now be further described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a plan view of a gliding anchor according to the invention;

Figure 2 is a side view along line 2—2 of the gliding anchor shown in Figure 1;

Figure 3 is an aft view of the gliding anchor shown in Figures 1 and 2;

Figure 4 is a schematic diagram of the anchor shown in Figures 1 to 3 as it travels along its glide path toward the bottom of a body of water;

Figure 5 is a schematic side view of a sea anchor assembly according to the invention;

Figure 6 is a plan view of the assembly shown in Figure 5;

Figure 7 is an enlarged detail of Figure 5;

Figure 8 is a side view of the assembly showing the sea anchors deployed; and

Figure 9 is a block diagram of a system which can be used in the assembly of Figure 5 to provide the deployment and later the take up of the anchor lines.

Referring to Figures 1 to 3, the gliding sea anchor shown comprises a main body 10 having wings 12 and 14 attached to the sides thereof. Further, the anchor has a drag skirt or tail cone 16 which, as shown by broken lines 18, has a hollow interior. In addition to the tail cone 16 there are horizontal stabilizer fins 20 and 22 which are attached to both the tail cone 16 and the body 10. In the illustrated preferred embodiment of the invention, each of the wings 12 and 14 forms a 135 degree angle with the body 10 along its leading edge and a 90 degree angle with the body 10 along its trailing edge. The tail cone 16 has a 135 degree angle, as also do the leading edges of the stabilizer fins 20 and 22, with respect to one another. The vertical lift or incidence angle of the wings 12 and 14 as shown in Figure 2, is 11 degrees. As shown in Figure 3, the trailing edge of each of the wings 12 and 14 forms a 30 degree dihedral angle with horizontal. The base diameter of the cone 16 is approximately twice the diameter of the body 10. The ratio of length of the body 10 to its diameter is 4.5:1. The above dimensions are not critical and are intended to give a glide path angle of approximately 45 degrees. Other factors such as weight distribution throughout the body may influence the glide path angle. Preferably, the body 10 is a solid mass.

In Figure 4, the anchor described above is shown diagrammatically when descending in a body of water along a glide path 28 at a predetermined angle β relative to horizontal 32. The anchor has an X axis which makes an angle of attack α with the glide path 28 and which is normally intersected at the centre of gravity 30 of the anchor by a Z axis. A Y axis (not shown) passes through the centre of gravity 30 normally to a plane including the X and Z axes i.e. the plane of the drawings. The force of DRAG produced by the tail, LIFT produced by the wings and GRAVITY, are applied in the general directions of the respective arrows. The forces of DRAG and LIFT are substantially in balance, so that the anchor has stability about its Y axis, and together react vertically through the centre of gravity 30 against the force of GRAVITY. By changing the angle of the stabilizer fins 20, 22 (not shown in Figure 4) with respect to the X axis and/or changing the amount of drag, the gliding characteristics of the anchor can be changed. It is desirable to obtain balanced forces in all directions in order to maintain a stable glide path in a given direction. The hollow tail cone 16 (Figures 1—3) in addition to producing drag forces while the anchor is gliding, serves as a scoop to provide drag anchorage when the anchor is at its station with the anchor line attached to it at the interior apex of the tail cone 16.

Figures 5 and 6 illustrate the preferred sea anchor assembly which includes a support in the form of a floatation body or buoy 110, shown entering a body of water 112. The buoy 110 supports an antenna 114 on its upper side and has three guide rods 116, 118, 120 extending from its underside. The guides 116—120 are separated from one another by 120° in azimuth and extend downwardly at an angle of 45° from the horizon. Each guide rod 116, 118, 120 has slidably mounted on it, a gliding anchor 122 which comprises the anchor described with reference to and illustrated in Figures 1 to 4 and which, for convenience of illustration, is

shown only diagrammatically in Figures 5 to 8.

Figure 7 shows part of the preferred means by which each anchor is released with an initial velocity along its respective guide from the buoy 110 for deployment. Only the guide rod 120 is shown on which the anchor 122 is slidably mounted and is urged by a spring 121, reacting against a part of the buoy 110, to slide along and off the free end of the guide rod 120. The spring 121 provides the aforesaid initial velocity. The anchor 122 has an eye 123 which is normally engaged by part of a latching mechanism (not shown) restraining the anchors 122 from deployment until such time as the mechanism is operated to release the anchors.

Figure 8 shows the assembly after the anchors 122 have been released from the buoy 110 on respective anchor lines 124 and have deployed themselves to the bottom of the body of water 112. As shown, the combined weight of the anchors 122 is such as to anchor the buoy 110 submerged below the surface of the water. Sufficient slack is preferably allowed in the anchor lines 124 for the anchors to reach their respective stations before the buoy 110 is submerged, the lines 124 then being wound in on reels (not shown) located in the buoy 110 until the buoy is positioned at the required depth. One system by which this is achieved is described with reference to Figure 9.

In Figure 9 there is shown a preferred system for controlling the deployment of the anchors 122 and for positioning the buoy 110 at the required depth in a body of water. The system is housed in the buoy 110 and comprises a solenoid 142, associated with the latching mechanism previously mentioned, for releasing a respective anchor 148 at a predetermined time after deployment of the buoy 110, which time is determined by a clock 140. Alternatively, as shown in broken lines, a pressure sensor 155 can be used to cause energisation of the solenoid 142 when the buoy 110 is a predetermined distance beneath the surface of the water. The clock 140 also determines the time of actuation of a tachometer 144 which senses unreeling of the respective anchor lines and actuates a brake 150 when it senses that the anchor has reached its station, thus preventing further unreeling of the line. After a period of time controlled by the clock, a winch 146 is used to reel in a predetermined amount of anchor line on reel 149 to lower the buoy 110 below the surface of the water.

The anchors may, as already stated, have more weight than the buoyant force of the buoy 110 so as to pull the buoy 110 beneath the surface of the water if this form of mooring is so desired. Alternatively, the anchors need not weigh as much as the buoyant force of the buoy 110. Tangential drag on the slack that is necessary in the lines connected to the anchors may pull the buoy beneath the surface of the water, though this will not have the effect of pulling in the anchors once the anchors are embedded in the sea bottom. The anchors, after being deployed at a given initial velocity to help maintain the correct direction will, given a sufficient length of line, continue to glide in that direction at a given design glide angle until reaching the bottom of the body of water at which time they act in the capacity of a normal anchor.

WHAT WE CLAIM IS:—

1. A seal anchor comprising a torpedo-shaped body provided with wings and a flared tail for producing lift and drag, respectively, in a ratio that determines a glide path angle, at an acute angle relative to horizontal, which the anchor follows on sinking under its own weight in a body of water, the anchor body being further provided with fins for stabilizing the anchor in its glide path.

2. A sea anchor according to claim 1, in which the ratio of lift to drag is substantially 1:1.

3. A seal anchor according to either claim 1 or claim 2, in which the wings are such that the centre of lift is coincident with the centre of gravity.

4. A sea anchor according to any one of claims 1 to 3, in which the tail has a conical configuration flared in a direction away from the main body of the anchor.

5. A sea anchor assembly comprising at least two sea anchors each according to any one of the preceding claims and all mounted on a support in such predetermined attitudes relative to one another that when they are deployed, simultaneously, from the support in a body of water they glide along divergent paths to widely separated stations at the bottom of the body of water, each anchor trailing behind it a respective anchor line that leads back to the support.

6. An assembly according to claim 5, in which the support comprises a floatation body having at least two elongated guides extending from its underside, the guides respectively carrying the anchors and being arranged to direct the anchors along their respective glide paths.

7. An assembly according to claim 6, in which each anchor is urged to slide off its respective guide by a spring and is normally restrained from doing so by a latch mechanism.

8. An assembly according to either claim 6 or claim 7, in which the floatation body carries the anchor lines and means for controlling the length of line between each anchor and the support once the anchors have been released.

9. A sea anchor assembly constructed and arranged to operate substantially as hereinbefore described with reference to Figures 5 to 8 of the accompanying drawings.

10. A sea anchor constructed and shaped to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 4 of the accompanying drawings.

For the Applicants,
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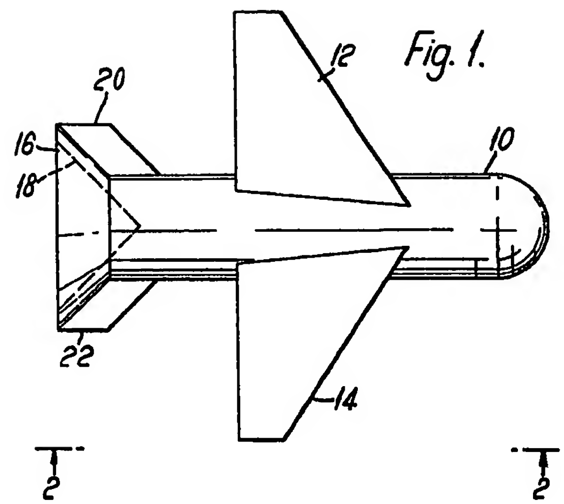

Fig. 1.

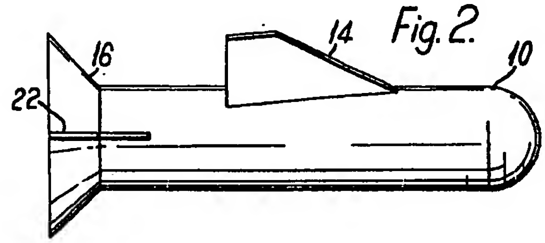

Fig. 2.

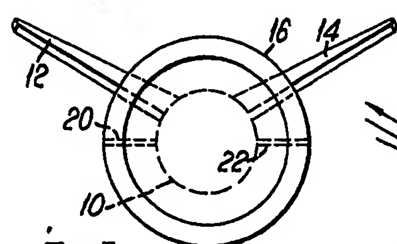

Fig. 3.

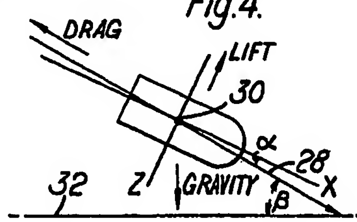

Fig. 4.

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2 SHEETS drawing is a reproduction of the Original on a reduced scale
Sheet 2

Fig. 5.

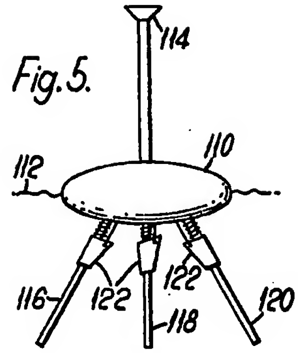

Fig. 6.

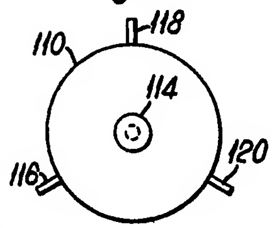

Fig. 7.

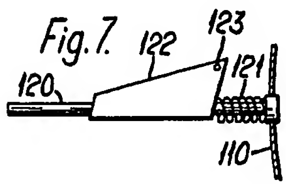

Fig. 8.

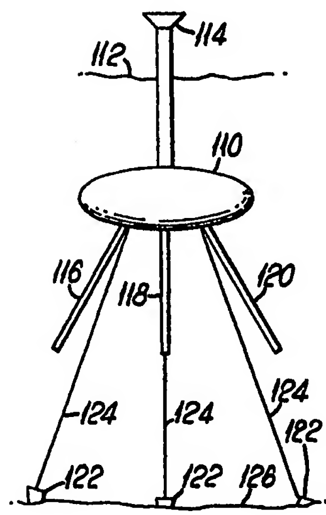

Fig. 9.